

ViP2P: XML Warehousing in P2P Networks

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Equipe Leo

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Supported by: *ANR-08-DEFIS-004 CODEX, INRIA ADT ViP2P & ViRDF*

Leo and friends in front of our lab



Part I

Introduction

Motivation

Distributed data management: old goal (1970)

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- distributed versions of industrial-strength DBMSs
- map/reduce style systems for massively parallel computations

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- distributed versions of industrial-strength DBMSs
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Still missing: the **flexible federation**

- high independence of the sites: when to be in, what to store
- **data distribution transparency**
- ... with the usual performance requirements

Distributed warehouses of Web content

Web content

structured documents, schemas, annotations, concepts, mappings,
Web services, inter-document links

Web content warehouse

Distributed database of selected content, whose users may:

- publish resources
- connect (annotate, map, link...) existing resources
- update resources
- **enhance** resources by combining them

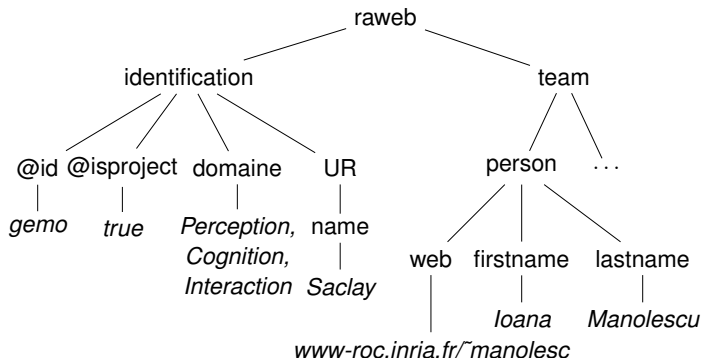
In the style of the RNTL WebContent project (2005-2009)

INRIA annual activity report in XML

<https://irabot.inrialpes.fr/RA2009/gemo.xml>

```
<?xml version="1.0" encoding="iso-8859-1"?>
<!DOCTYPE raweb PUBLIC "raweb2.dtd">
<raweb year="2009">
  <identification id="gemo" isproject="true">
    <shortname>gemo</shortname>
    <domaine>Perception, Cognition, Interaction</domaine>
    <UR name="Saclay"/>
  </identification>
  <team>
    <person>
      <web>http://www-roc.inria.fr/~manolesc</web>
      <firstname>Ioana</firstname>
      <lastname>Manolescu</lastname>
    </person>...
  </team>...
</raweb>
```

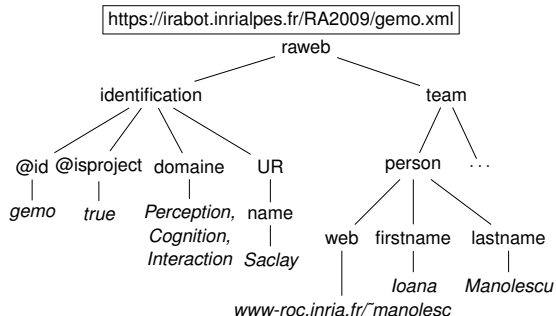

INRIA annual activity report in XML



- (Very) popular data exchange format
- Many W3C standards + efficient tools

XML and the Semantic Web

XML



RDF

`http://gemo.saclay.inria.fr`
wroteReport

`https://irabot.inrialpes.fr/RA2009/gemo.xml`

`http://gemo.saclay.inria.fr`
coordinates

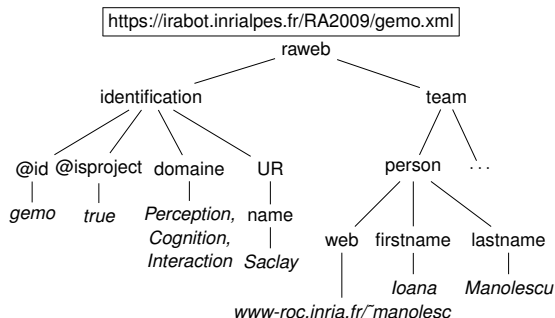
`http://codex.saclay.inria.fr`

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hasType

`http://www.inria.fr/types.xsd#ContratFR`

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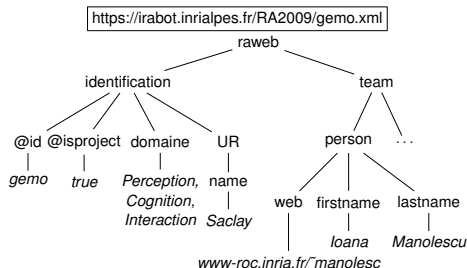
`http://www.inria.fr/types.xsd#ContratFR`

Possible queries

- European projects involving at least two INRIA teams?
- Most frequent keywords for each INRIA theme?
- PhD students co-supervised with a foreign University?

Distributed warehouses of Web content

Distributed XML



<http://gemo.saclay.inria.fr>

<http://codex.saclay.inria.fr>



Distributed RDF

Serv. Inf.
Sci. Tech.
INRIA

<http://pierre.senellart.com>
collaboratesWith
<https://gemo.saclay.inria.fr>

Indiana
Univ.

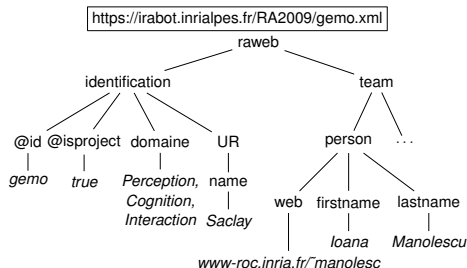
<http://pierre.senellart.com>
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dbweb.enst.fr/events/sigmod10contest/

Splitted
Desktop

<http://gemo.saclay.inria.fr>
possibleCollaborator
<http://www.splitted-desktop.com/fr/>

Distributed warehouses of Web content

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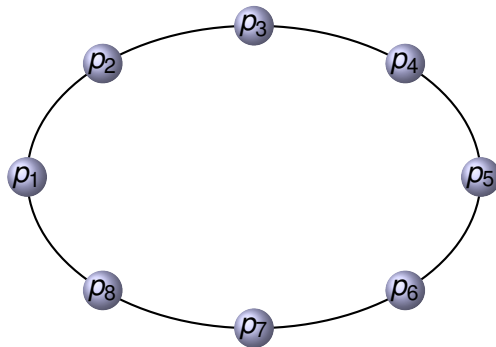
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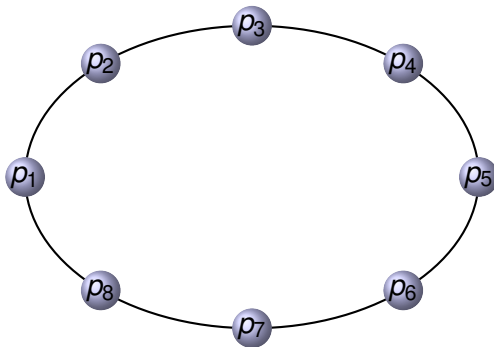
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- French researchers involved in ACM conference organization?
- Possible collaborators for a data management project in the clouds?

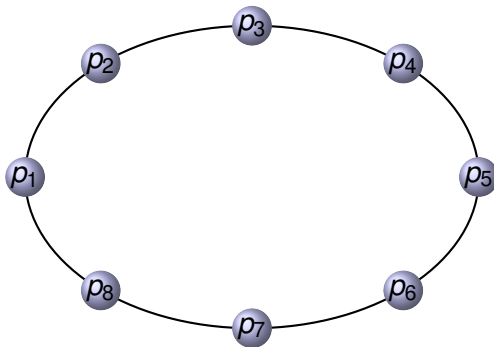
Distributed hash tables



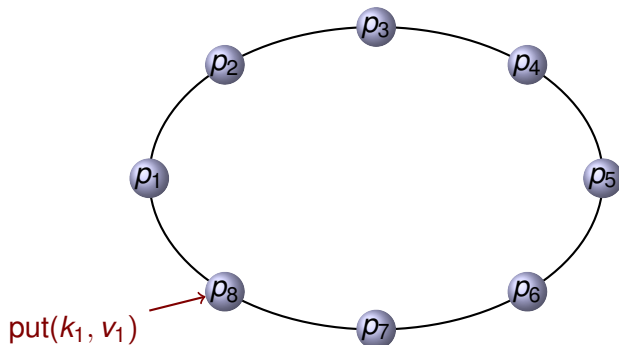
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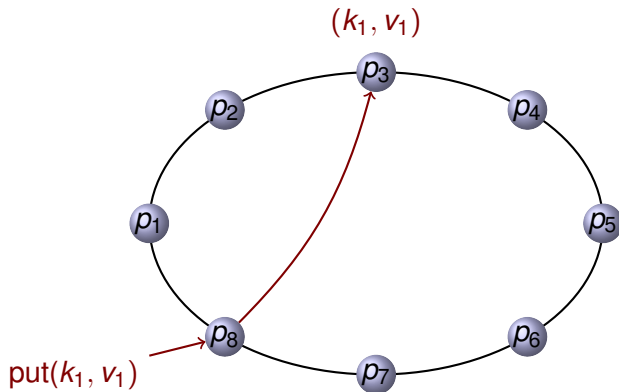
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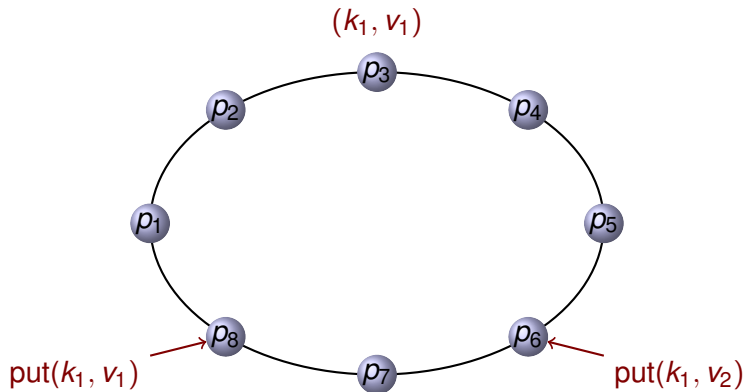
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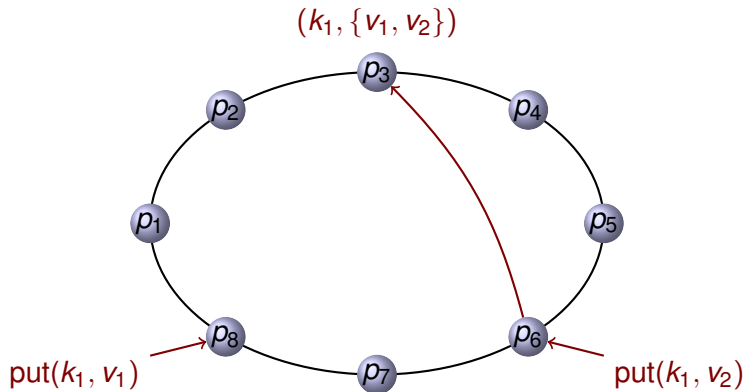
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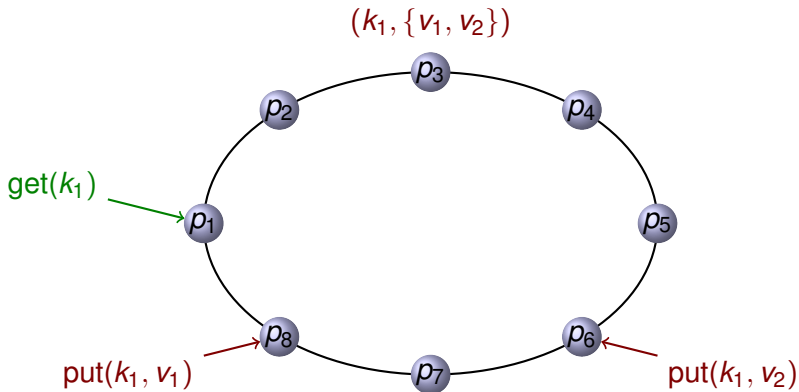
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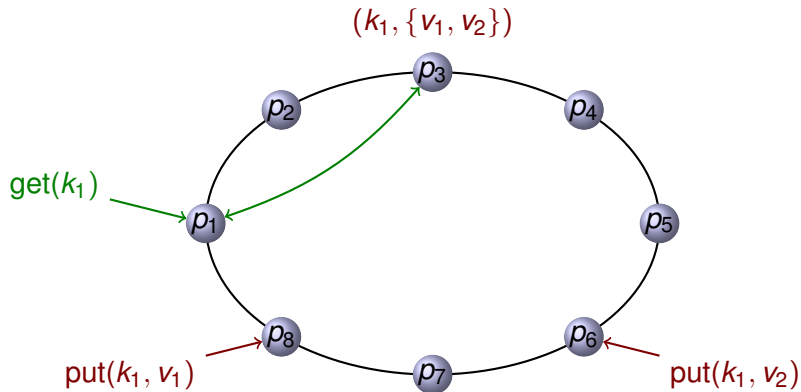
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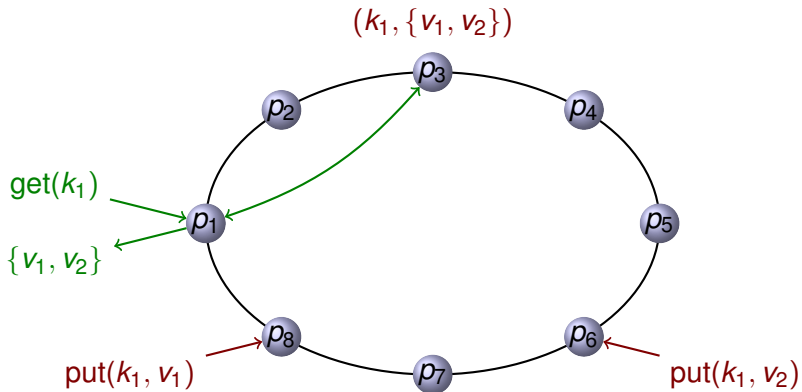
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Distributed hash tables



Distributed hash tables



What distributed hash tables provide

Dynamic peer networks

- each peer is assigned an **id** \Rightarrow **address range**
- bound of $\log_2(N)$ hops to route a message to peer
- **network re-adjustment** when peers join or leave: peers' address spaces stretch and contract

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(Key, value) stores = basis for content sharing

- **index** the resources by **keys**
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Main DHT functionality

Small shared memory \Rightarrow resource catalog

From DHTs to distributed data management

Functionalities to add

- data indexing
- **storage** for application data and even DHT index data
- local query processing
- **distributed query processing**: operators, including **data transfers**, optimization . . .

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Reliability

- provided** a peer will eventually answer at each address
some (key, value) replication to handle peer failures
(broadcast to k replicas)
- to do** resilience of all added functionalities to peer joining/leaving/failing

Querying distributed data on a DHT

Two types of operations:

- 1 Look up useful data sources in the DHT
 - Documents matching the query
 - Documents which *might* match the query

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- 2 Remaining query evaluation steps
 - **evaluate** sub-queries to extract partial results
 - **combine** partial results
 - **transfer** results to query peer

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Distributed query processing “as usual”

Trade-offs in DHT indexing and query processing

Level of detail of resource indexing

- lookup precision ↗ ⇒ execution time ↘
- data publication time ↗, possibly execution time ↗

Data re-placement or clustering

- fewer peers contacted for a query (message no. ↘, execution time ?)
- data transfers in the absence of queries (message no. ↗, total message size ↗)

Part II

ViP2P: materialized views on DHTs

5 Credits

6 ViP2P overview

7 ViP2P views

8 ViP2P rewritings

9 The distributed platform

Joint work with

Students

- Konstantinos Karanasos, Asterios Katsifodimos, Spyros Zoupanos (PhD 2009)
- Martin Goodfellow (U. Strathclyde), Silviu Julean (UVT, Romania), Varunesh Mishra (IIT Kanpur), Alexandra Roatis (UVT, Romania)

Engineers

Jesús Camacho-Rodriguez, Julien Leblay, Alin Tilea

Friends from abroad

Angela Bonifati (CNR Italy), Vasilis Vassalos (AUER, Greece)

Web data sharing in ViP2P

Web data:

- XML documents
- RDF annotations

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Choices:

Web data sharing in ViP2P

Web data:

- XML documents
- RDF annotations

Choices:

- peers retain control over the data they store/publish
 - no global schema
 - **documents** published independently
 - **annotations** (triples) can freely connect content
- content is re-distributed: peers may accumulate results of long-running queries
- peers share their accumulated results with others

Behind the scene: distributed materialized views

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Long-running query = subscription = view

Declarative specification of results that the peer is interested in

- tree pattern \Rightarrow matches an individual document
- tree patterns with value joins \Rightarrow matches across distinct documents
- corresponding XQuery dialect

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Query planning = rewriting queries using views

Find relevant views \Rightarrow rewrite the query \Rightarrow optimize the rewriting

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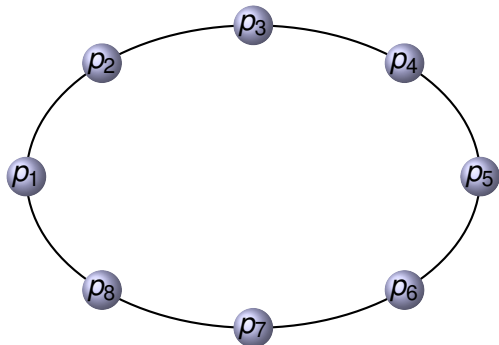
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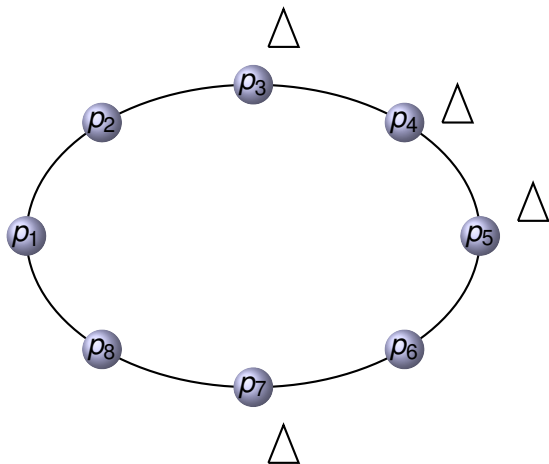
Query execution = distributed query processing

With XML- and RDF-specific bells & whistles

Publishing and querying in ViP2P



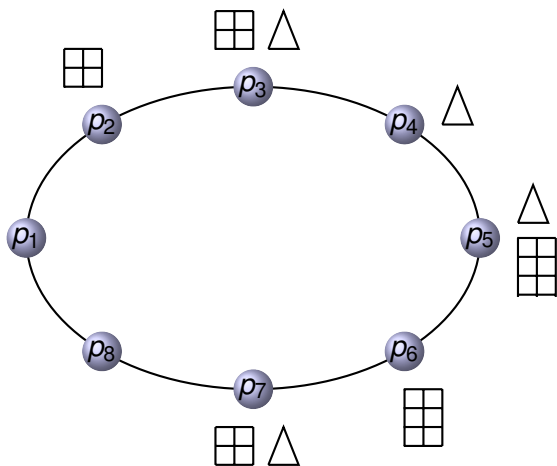
Publishing and querying in ViP2P



The peers may store:

- documents, annotations

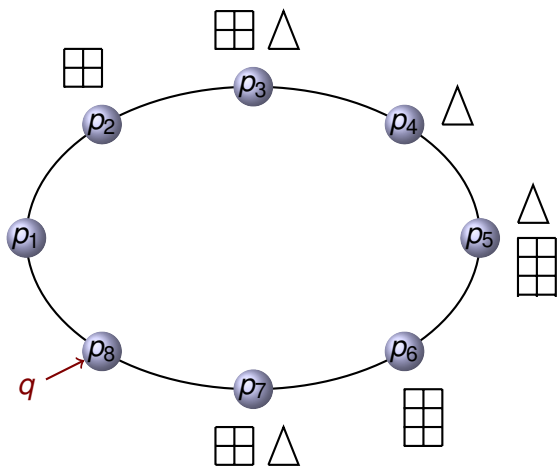
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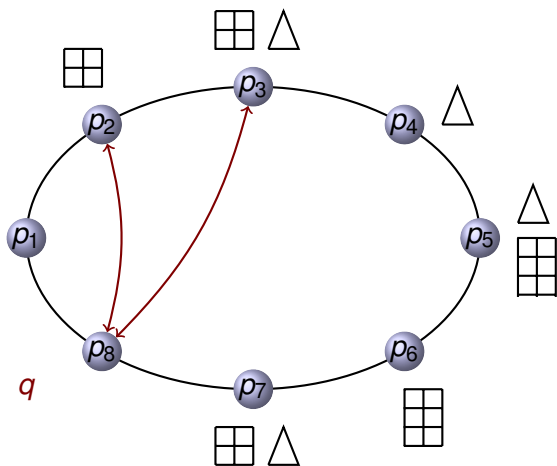
- documents, annotations
- views

Publishing and querying in ViP2P



When q arrives:

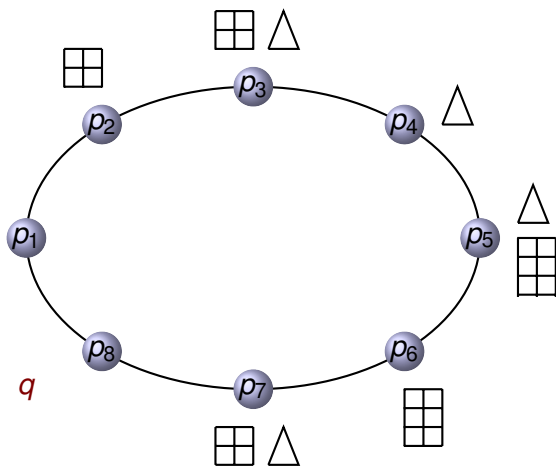
Publishing and querying in ViP2P



When q arrives:

- view definition lookup

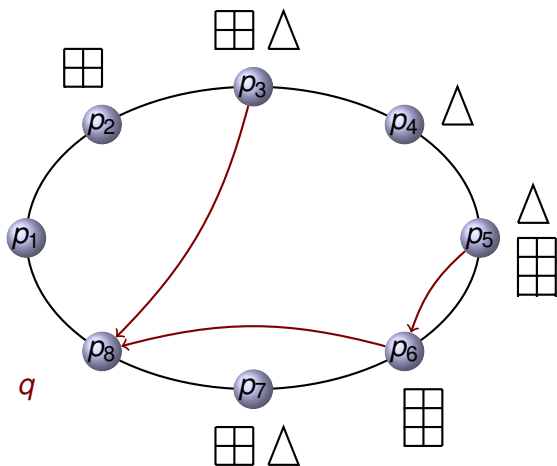
Publishing and querying in ViP2P



When q arrives:

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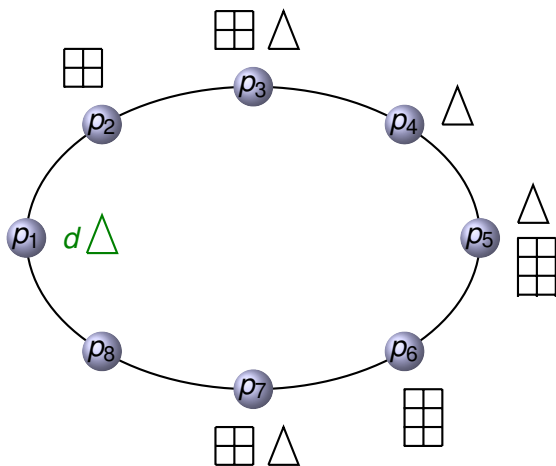
Publishing and querying in ViP2P



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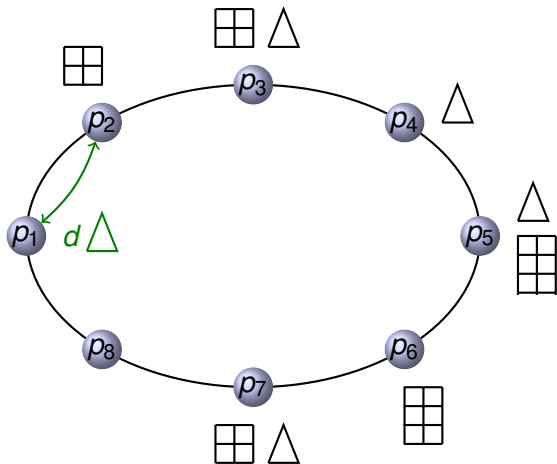
- view definition lookup
- rewriting
- execution of physical plan

Publishing and querying in ViP2P



When d arrives:

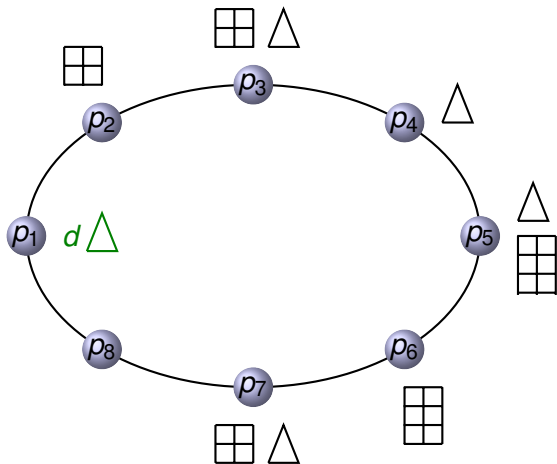
Publishing and querying in ViP2P



When d arrives:

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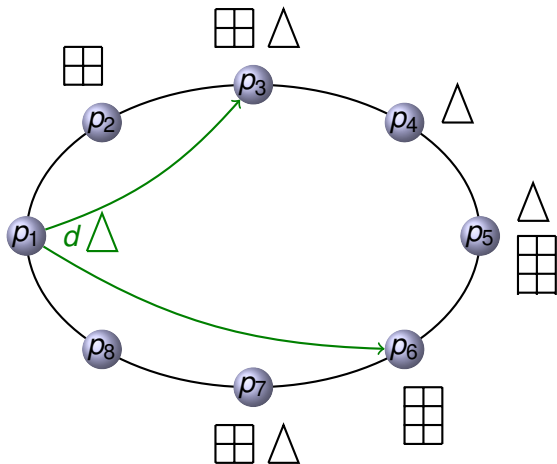
Publishing and querying in ViP2P



When d arrives:

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Publishing and querying in ViP2P

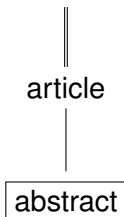


When d arrives:

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- compute $v_i(d)$
- send results

Sample views

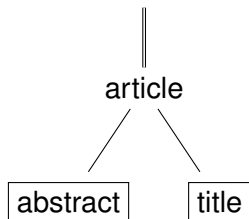
All article abstracts



| URI | abstract |
|---|-------------------|
| http://peer1.com/doc1.xml | Databases... |
| http://peer2.com/f2.xml | XML processing... |
| ... | ... |

Sample views

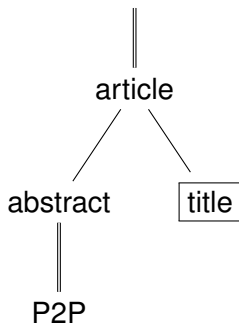
Titles and abstracts of all articles



| URI | abstract | title |
|-----|----------|-------|
| ... | ... | ... |

Sample views

Titles of all articles having “P2P” in the abstract



| URI | title |
|-----|-------|
| ... | ... |

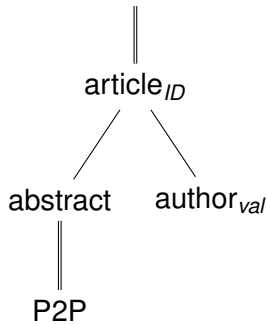
Sample views

URIs of all documents containing
articles having “P2P” in the abstract



Sample views

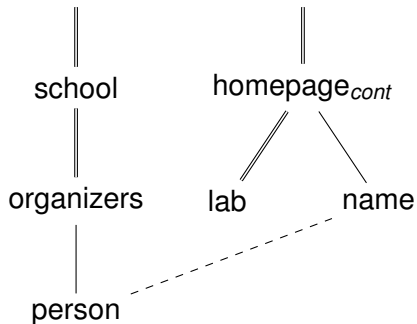
IDs and authors of all articles having
“P2P” in the abstract



| URI | article.ID | author.val |
|-----|------------|------------|
| ... | ... | ... |

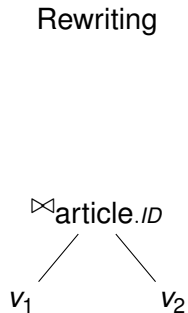
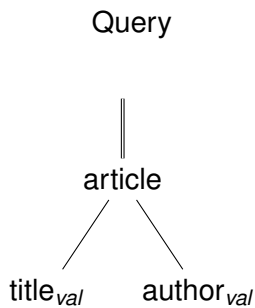
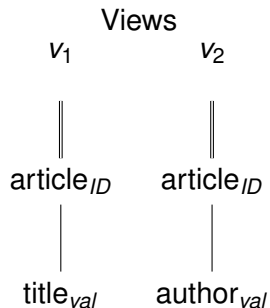
Sample views

Homepages of all WebDam summer school organizers



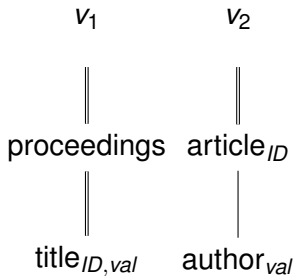
| URI1 | URI2 | homepage.cont |
|------|------|---------------|
| ... | ... | ... |

Sample rewritings

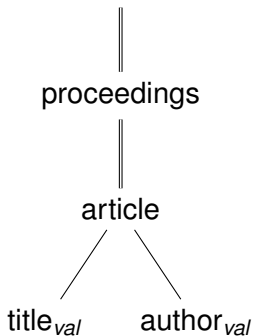


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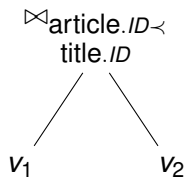
Views



Query

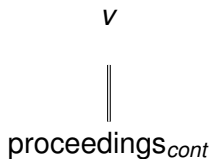


Rewriting

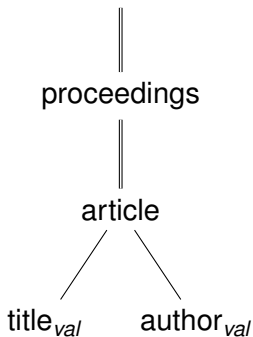


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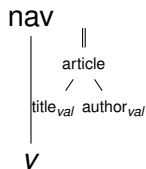
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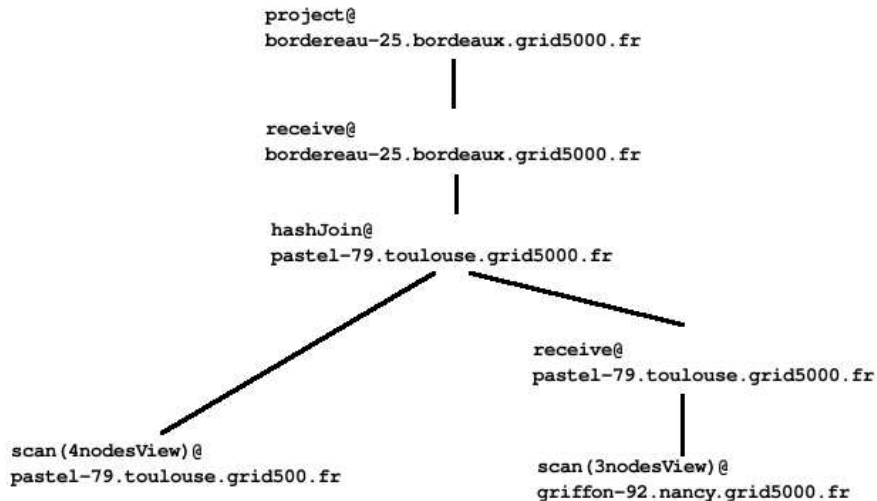
Query



Rewriting



Sample physical rewriting plan



ViP2P platform

- 70.000 Java lines (330 classes) and decreasing :)
- Uses Berkeley DB (version 3.3.75) to store view data
- Uses FreePastry (version 2.1) as our DHT network
- Experiments carried on *Grid5000* using **250 machines**
- Deployed on **1000 ViP2P peers**

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Algorithms inside:

- SAX-based custom processor for computing $v(d)$ + identifiers
- Iterator-based execution engine, (nested) tuples
- Send/receive for distributed execution + URI compression
- Many query optimization strategies

Indexing views for view materialization

View indexing

For each view v and node label l in v , put (l, v)

For each view v and constant k in v , put (k, v)

Indexing views for view materialization

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View lookup

For each document d and node label l in d , get(l)

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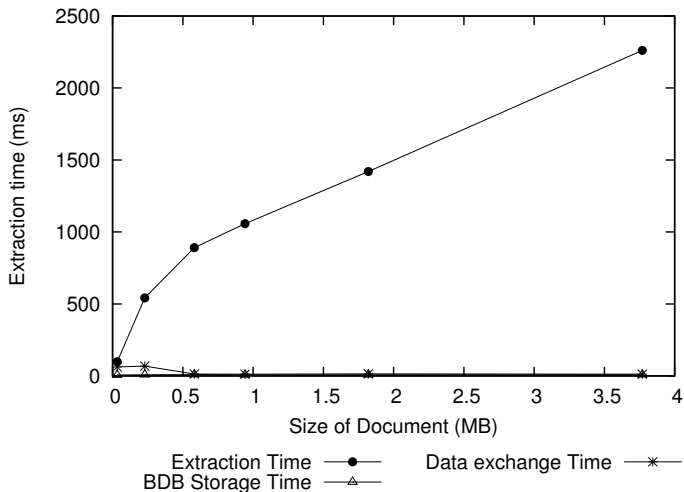
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Evaluate the filtered view set on d

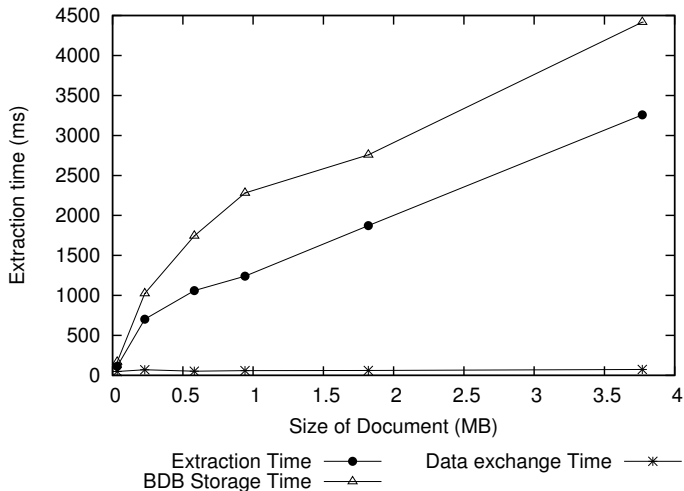
View materialization

View + documents = few results



View materialization

View + documents = many results



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Indexing views for query rewriting

View indexing

For each view v and node label l in v , put (l, v)

For each view v and constant k in v , put (k, v)

View lookup

For each query q and label l in q , get(l)

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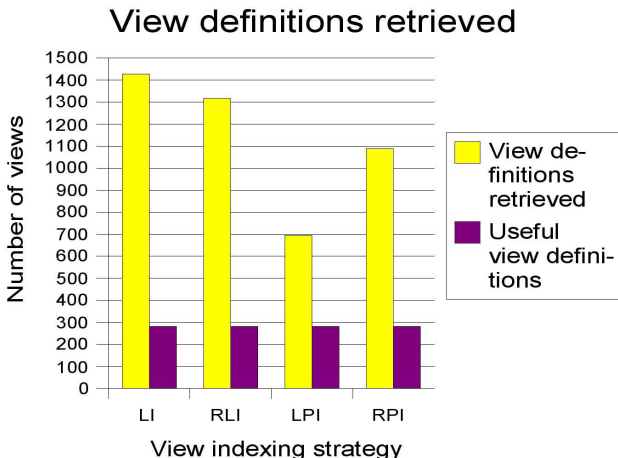
Filter the views thus obtained:

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Rewrite q with the filtered view set

View look up performance

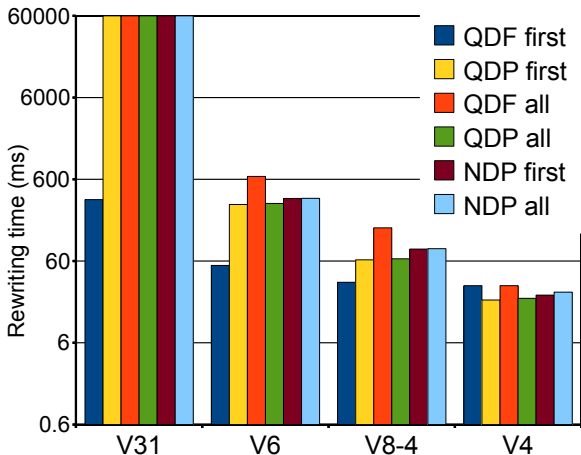
1440 views related to a 32-nodes query q



View rewriting performance

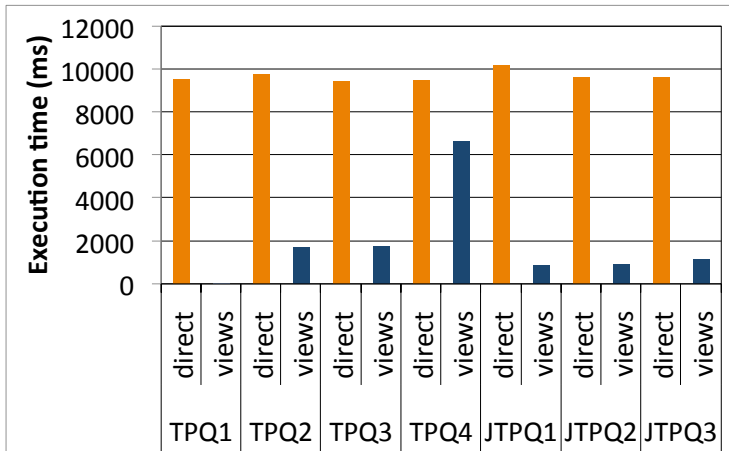
We find **minimal** rewritings

NP-hard problem; heuristics for finding some rewriting fast



The interest of view-based rewriting

Almost-XMark queries



Part III

Summary

We have

A distributed engine for sharing XML data based on materialized views

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A distributed engine for sharing XML data based on materialized views

We are working on

- 1 XML+RDF management (K. Karanasos, F. Goasdoué)
- 2 Self-adaptive views (A. Katsifodimos, J. Camacho-Rodriguez, V. Mishra)
- 3 Incremental view maintenance (M. Goodfellow, A. Bonifati)
- 4 Query optimization (A. Roatis)

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Blue sky

- 1 Pure RDF management in P2P
- 2 Moving the back-end into the clouds (EnergieNet)

Closest related works

DHT-based sharing of relations [LHSH04]

DHT-based XML indexing [GWJD03, BC06, SHA05, AMP⁺08]

DHT-based shared XML caches [LP08]

XPath query rewriting [BOB⁺04, XO05, CDO08, TYÖ⁺08]

- XPath: wildcard *, union
- Rewritings: intersection, navigations, joins

Rewriting with structural constraints [ABMP07]

- Centralized setting
- Dataguide [GW97] constraints

Layered architecture for Web content warehousing [AAC⁺08]

RDF querying and reasoning on DHT [KMK08, LIK06]

Thank you!

<http://vip2p.saclay.inria.fr>

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